



## TRANSLATION

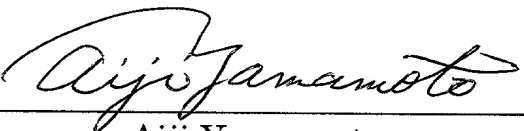
I, Aiji Yamamoto, residing at 1-13-16, Shibayama, Funabashi-shi, Chiba-ken, Japan, state:

that I know well both the Japanese and English languages;

that I translated, from Japanese into English, the specification, claims, abstract and drawings as filed in U.S. Patent Application No. 09/901,548, filed July 9, 2001; and

that the attached English translation is a true and accurate translation to the best of my knowledge and belief.

Dated: October 17, 2001

  
Aiji Yamamoto

09901548-131101

TITLE OF THE INVENTION

MICROSCOPE FOCUSING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application is based upon and claims the  
benefit of priority from the prior Japanese Patent  
Applications No. 2000-208998, filed July 10, 2000; and  
No. 2001-203058, filed July 4, 2001, the entire  
contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

10 The present invention relates to a microscope  
focusing apparatus for vertically moving a microscope  
including a light illuminator for lighting a sample,  
and focusing on the sample.

15 A conventional example of a microscope focusing  
apparatus is disclosed in USP 4,729,646. The apparatus  
is a microscope supporting module type apparatus  
including a linearly movable microscope holder for  
holding a microscope by a fastener disposed in an  
opening, a linearly movable slide member for supporting  
20 the holder with a fixing screw, and a focusing main  
body including a column for holding the slide member.  
In the apparatus, a constituted main component is  
formed of an extruded/processed material, and an  
attachment unit can inexpensively be attached to the  
25 column.

Moreover, in an apparatus disclosed in  
USP 4,565,427, an additional drive transmission

apparatus disposed between a focusing drive  
transmission apparatus and a stage holder is used to  
rapidly adjust and dispose the microscope in a  
predetermined position. In the drive transmission  
5 apparatus, an eccentric member disposed in the stage  
holder is rotated by an auxiliary handle disposed  
separately from a focusing handle, and a stage is  
raised/lowered to a predetermined height.

With the microscope incorporated for use in an  
10 apparatus in a manufacturing factory, and the like,  
since the microscope holder is of an opening type in  
the module type focusing apparatus disclosed in the  
USP 4,729,646, a shape of the attached microscope is  
limited by an opening shape.

15 A microscope including a light illuminator for  
lighting a sample is generally attached to a microscope  
frame comprising a stage on which the sample is to be  
mounted and a focusing mechanism for focusing on the  
sample. Therefore, the microscope is not configured  
20 to be attached to the opening like the microscope  
holder. For example, a relatively light illuminator is  
fixed with a round dovetail. For a heavy light  
illuminator, since a round dovetail system has an  
insufficient rigidity, a bolt fixing system or the like  
25 is employed.

Moreover, a weight of the microscope largely  
differs, and a load outside an ability range is applied

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to the focusing main body. Then, the microscope is naturally lowered and the sample cannot be focused.

Furthermore, since a gravity position of the microscope is not coaxial with a focus moving axis of the focusing main body, a moment is added to a guide of the focusing main body besides the load of a moving axis. When the gravity position and weight of the microscope largely differ and a moment exceeding an allowable rigidity of the guide is added, an image blur occurs, and a satisfactory observed image cannot be obtained.

On the other hand, in the additional drive transmission apparatus disclosed in the USP 4,565,427, the auxiliary handle is used to rapidly and vertically move the stage by the predetermined height, and a reduction ratio of the focusing handle cannot be selected.

In these conventional arts, the microscope focusing apparatus is exclusively used and a separate focusing handle apparatus is added. Moreover, for the microscope holder, the microscope is inserted and fixed in the slide member by engagement using a slide dovetail. Therefore, in order to smoothly attach the microscope to the slide member, a high-precision slide dovetail processing is required.

#### BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to provide a

microscope focusing apparatus which can broadly and inexpensively be attached to a microscope.

According to the present invention, there is provided a microscope focusing apparatus comprising: a  
5 light illuminator; an objective lens; an observation tube; a holder which holds the light illuminator, the objective lens and the observation tube; a focusing main body including a focusing movable portion which linearly and vertically moves; and an attaching portion,  
10 formed in the focusing movable portion, which fixes the holder, wherein the holder comprises a first holder including a first support, the first support disposed on an observation optical axis, which supports the light illuminator, and a second holder including a  
15 second support, the second support disposed outside the observation optical axis, which supports the light illuminator, and one of the first and second holders can be selectively attached to the attaching portion.

Additional objects and advantages of the invention  
20 will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and  
obtained by means of the instrumentalities and  
25 combinations particularly pointed out hereinafter.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated

in and constitute a part of the specification,  
illustrate presently preferred embodiments of the  
invention, and together with the general description  
given above and the detailed description of the  
5 preferred embodiments given below, serve to explain the  
principles of the invention.

FIG. 1 is a side view showing a schematic  
configuration of a microscope focusing apparatus  
according to an embodiment of the present invention.

10 FIG. 2 is a front view showing the schematic  
configuration of the microscope focusing apparatus  
according to the embodiment of the present invention.

FIG. 3 is a schematic sectional view of a  
focusing main body as viewed from above according  
15 to the embodiment of the present invention, and also  
shows a shape of an attaching portion of a microscope  
holder.

FIG. 4 is a schematic side sectional view of the  
microscope holder according to the embodiment of the  
20 present invention.

FIG. 5 is a diagram showing an assembled state of  
the microscope holder, the focusing main body and a  
light illuminator according to the embodiment of the  
present invention.

25 FIG. 6 is a diagram showing an assembled state of  
the microscope holder and light illuminator in the  
microscope focusing apparatus according to a

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modification example of the embodiment of the present invention.

FIG. 7 is a schematic side sectional view showing the configuration of the microscope focusing apparatus according to another embodiment of the present invention.

FIG. 8 is an appearance view of a weight balance spring unit according to the embodiment of the present invention.

FIG. 9 is a diagram showing an attached state of the weight balance spring unit in a bottom of the focusing main body according to the embodiment of the present invention.

FIG. 10 is a diagram showing the schematic configuration of the microscope focusing apparatus according to another embodiment of the present invention.

FIG. 11 is a schematic sectional view showing a structure of a guide portion as viewed from above according to the embodiment of the present invention.

FIG. 12 is an appearance view of the guide portion as viewed from a back surface thereof according to the embodiment of the present invention.

FIG. 13 is a diagram showing the schematic configuration of the microscope focusing apparatus according to another embodiment of the present invention.

FIG. 14 is a schematic sectional view showing structures of the guide portion and a middle gear unit as viewed from above according to the embodiment of the present invention.

5        FIG. 15A is a side view showing a configuration in which the microscope focusing apparatus according to the embodiment of the present invention is applied to various apparatuses.

10       FIG. 15B is a schematic plan sectional view showing the configuration in which the microscope focusing apparatus according to the embodiment of the present invention is applied to various apparatuses.

#### DETAILED DESCRIPTION OF THE INVENTION

15       Preferred embodiments of the present invention will be described hereinafter with reference to the drawings.

20       FIGS. 1 and 2 are views showing a schematic configuration of a microscope focusing apparatus according to a first embodiment of the present invention, FIG. 1 is a side view, and FIG. 2 is a front view.

25       This microscope focusing apparatus has a microscope 1, and a focusing main body 10 for vertically moving a microscope holder 20 for supporting the microscope 1 (e.g., an observation tube) to focus on a sample 70. The focusing main body 10 has a focusing handle 16 for vertically moving the microscope



holder 20, and is fixed to a pole 90a disposed on a stand 90 with a fastener 18.

A revolver 60 for holding a plurality of objective lenses 50 is attached to a lower surface of the microscope holder 20. The revolver 60 with the objective lenses 50 attached thereto can freely rotate. When the revolver 60 is rotated/positioned, the objective lens 50 having a predetermined magnification can be disposed on an optical axis (observation optical axis) L.

On the other hand, a light illuminator 40 for projecting a lighting light to the sample 70 is attached to an upper surface of the microscope holder 20. A lamp light source 42 is disposed on an end of the light illuminator 40, and the lamp light source 42 is connected to a power source 45 via a power cable 44.

The lighting light emitted from the lamp light source 42 changes its direction to a downward direction by a half mirror 43 in the light illuminator 40, and the sample 70 is irradiated via the microscope holder 20, revolver 60, and objective lens 50. An observed image of the sample 70 is incident upon an observation tube 80 attached to an upper portion of the light illuminator 40 via the objective lens 50, and is observed through an eyepiece lens 81.

FIG. 3 is a schematic sectional view of the

focusing main body 10 as viewed from above, and also shows a shape of an attaching portion of the microscope holder 20.

5 A focusing movable portion 11 has an attaching surface 11a for attaching the microscope holder 20, screw holes 11b, 11b, and a concave positioning portion 11c for positioning the attaching portion.

10 Surfaces 11d, 11d contacting cylindrical rollers 13, 13 movable along guide grooves 12a, 12a are formed between the guide grooves 12a, 12a of a focusing main body frame 12 in opposite side surfaces of the focusing movable portion 11, and a rack 11e is configured on an opposite side of the attaching surface 11a.

15 The rack 11e meshes with a pinion 14a disposed on a handle rotary shaft 14, and the focusing movable portion 11 linearly and vertically moves along the guide grooves 12a, 12a with rotation of the pinion 14a in the handle rotation axis 14.

20 The handle rotary shaft 14 has a pinion shaft 14b forming the pinion 14a, coarse movement rotary shaft 14c, slight movement rotary shaft 14d, and a rotation support frame 14e for supporting the pinion shaft 14b, and the rotation support frame 14e is fixed to the focusing main body frame 12 with screws 15, 15.

25 As is generally known and not shown, the coarse movement rotary shaft 14c is connected to the pinion shaft 14b, and a coarse movement handle 16a is fixed to

the coarse movement rotary shaft 14c. Moreover, the slight movement rotary shaft 14d is connected to the pinion shaft 14b via a reduction gear, and a slight movement handle 16b is fixed to the slight movement rotary shaft 14d.

According to such configuration, when the coarse movement handle 16a is rotated, the pinion shaft 14b rotates. When the slight movement handle 16b is rotated, the pinion shaft 14b similarly rotates via the reduction gear, and the focusing movable portion 11 vertically moves as described above.

A coarse movement force amount adjustment handle 17 is screwed into the rotation support frame 14e. When the handle 17 is rotated to contract a spring 17a, a force of a pad 17b which presses the coarse movement handle 16a is changed, and a force amount of the coarse movement handle 16a is adjusted.

The force amount of the coarse movement handle 16a is adjusted in order to prevent the handle from being naturally lowered with respect to microscope holders 20, 21 (see FIG. 6) and an applied load. Moreover, the focusing main body 10 includes a hole 12b, fastener 18, and leaf spring 12c so that the focusing main body is attached to the pole 90a disposed on the stand 90 (see FIG. 1). When the fastener 18 is screwed into a screw hole 12d, the leaf spring 12c is pressed onto the pole 90a passed through the hole 12b, and the focusing main

body 10 is fixed.

FIG. 4 is a schematic side sectional view of the microscope holder 20, and FIG. 5 is a diagram showing an assembled state of the microscope holder 20, focusing main body 10 and light illuminator 40.

The microscope holder 20 has an attaching surface 20a and fixing hole 20b for attaching the microscope to the focusing movable portion 11, and a positioning portion 20c for positioning the microscope.

In order to assemble the microscope holder 20 and focusing main body 10, the attaching surface 11a disposed on the focusing movable portion 11 of the focusing main body 10 is brought into contact with the attaching surface 20a of the microscope holder 20, and the respective screw holes 11b of the focusing movable portion 11 and the respective fixing holes 20b of the microscope holder 20 are used to fix the microscope holder with four bolts 22 (see FIG. 5).

The microscope holder 20 is attached and positioned in vertical and horizontal directions by inserting the convex positioning portion 20c having wall surfaces 20c1, 20c2 perpendicular to the attaching surface 20a disposed on the microscope holder 20 into the concave positioning portion 11c having wall surfaces 11c1, 11c2 perpendicular to the attaching surface 11a disposed on the focusing movable portion 11, and allowing the convex positioning portion to abut on

the concave positioning portion.

In FIG. 4, the positioning portion 20c of the microscope holder 20 projects from the attaching surface 20a. However, the positioning portion 11c disposed on the focusing movable portion 11 (see FIG. 5) may project from the attaching portion 11a, and the positioning portion 20c of the microscope holder 20 may be concave with respect to the attaching surface 20a.

A round female dovetail 20d for attaching the round dovetail fixed type light illuminator 40 is formed in an upper surface of the microscope holder 20. A position of the optical axis L of the horizontal direction, which is determined by a center of the round female dovetail 20d, meets a center C (see FIG. 3) between the left and right guide grooves 12a, 12a disposed in the focusing main body 10 during assembling of the microscope holder 20 with the focusing main body 10.

The light illuminator 40 is securely positioned and fixed by attaching a round male dovetail 40a formed on the light illuminator 40 to the round female dovetail 20d of the microscope holder 20, and screwing a clamp screw 20f into a screw hole 20e formed in the microscope holder 20.

A slide female dovetail 20g for attaching the revolver 60 for holding the plurality of objective

lenses 50 is formed on a lower surface of the  
microscope holder 20. A slide male dovetail 60a formed  
on a back surface of the revolver 60 is inserted into  
the slide female dovetail 20g of the microscope holder  
5 20, and the revolver 60 is exactly positioned on the  
optical axis L determined by the round female dovetail  
20d by a protrusion 20h (see FIG. 4) disposed on the  
lower surface of the microscope holder 20.

Moreover, a screw hole 20i for fixing the revolver  
10 60 is disposed in a side surface of the slide female  
dovetail 20g of the microscope holder 20, a clamp screw  
20j is screwed into this screw hole 20i, and the  
revolver 60 is thus securely fixed.

FIG. 6 is a diagram showing an assembled state of  
15 the microscope holder 21 and a light illuminator 41 in  
the microscope focusing apparatus according to a  
modification example of the first embodiment.

In the modification example, the bolt fixed  
type light illuminator 41 heavier than the light  
20 illuminator 40 is used. As shown in FIG. 6, in order  
to assemble the light illuminator 41 with the focusing  
main body 10 (see FIG. 5), the microscope holder 21 has  
attaching surfaces 21a, 21a for fixing the light  
illuminator 41, a plurality of screw holes 21b, and a  
25 positioning portion 21c for positioning the light  
illuminator 41.

The positioning portion 21c has a contact portion

21d which can contact with a side surface 41a of the  
light illuminator 41 to position the light illuminator  
back and forth in FIG. 6, and a protrusion 21e which  
contacts with a wall surface 41b disposed on a bottom  
5 surface of the light illuminator 41 to position the  
light illuminator left and right. Thereby, the  
position of the optical axis L of the light illuminator  
41 can be set to a predetermined position with respect  
to the center C between the left and right guide  
10 grooves 12a, 12a of the focusing main body 10.

Additionally, as a modification example, the  
protrusion 21e is formed in a triangular prism shape,  
and an inclined surface of the protrusion forms an  
angle of 45° with respect to a longitudinal direction  
15 of the contact portion 21d. Then, the light  
illuminator 41 guided to the microscope holder 21 from  
a right direction of FIG. 6 is guided toward the  
contact 21d side and positioned by the protrusion 21e.

When the light illuminator 41 is attached to the  
20 microscope holder 21, four fixing counterbores 41c  
of the light illuminator 41 and four screw holes 21b  
of the microscope holder 21 are used to fix the  
light illuminator and microscope holder with respective  
bolts 23. The light illuminator and microscope holder  
25 are easily positioned by the aforementioned  
configuration.

The attaching of the microscope holder 21 to the

focusing main body 10 is not shown in FIG. 6. However,  
the attaching portion of the microscope holder 21 has a  
structure similar to that of the microscope holder 20,  
and an attaching method is the same. Moreover, the  
5 revolver 60 is directly attached with respect to the  
optical axis L of the bottom surface of the light  
illuminator 41. Therefore, as not shown in FIG. 6, a  
slide female dovetail, positioning protrusion, and  
screw hole for the clamp screw are formed in a portion  
10 of the bottom surface of the light illuminator 41  
around the optical axis L similar to the microscope  
holder 20. Thereby, the revolver 60 is securely fixed.

As described above, according to the microscope  
focusing apparatus of the first embodiment, when the  
15 microscope holders 20, 21 for supporting the microscope  
including the light illuminators 40, 41 are attached to  
or detached from the focusing main body 10, the present  
apparatus can easily be assembled in accordance with an  
attaching shape of the microscope without exclusively  
20 using the focusing main body 10.

Therefore, even in the microscope having a  
different attaching shape, when the microscope holders  
20, 21 are selected in accordance with the shape, the  
same microscope focusing apparatus can be used.

25 Therefore, it is unnecessary to possess a plurality of  
microscope focusing apparatuses, and the apparatus can  
be inexpensively provided. Furthermore, when the



microscope holder having a different length and size is selected, the position of the optical axis L of the microscope can be easily changed.

Since the optical axis L meets the center C  
5 between the guide grooves 12a, 12a of the focusing main body 10 as described above, the microscope holder 20 does not require a large space, and is suitable for a compact microscope system. On the other hand, the microscope holder 21 supports the microscope with the  
10 wall surface having general-purpose properties, and can therefore be used in a broad-range system.

The focusing main body 10 is independent of the microscope holders 20, 21. The focusing main body 10 can be attached to any type of microscope. Therefore,  
15 a cost increase of the focusing main body 10 does not occur.

Moreover, the wall surfaces 20c1, 20c2 perpendicular to the attaching surface 20a are utilized to attach the microscope holder 20 or 21 to the  
20 focusing main body 10. Therefore, no complicated processing is required, and the holder can be easily and securely positioned.

FIG. 7 is a schematic side sectional view showing the configuration of the microscope focusing apparatus  
25 according to a second embodiment of the present invention. In FIG. 7, the same portions as those of FIGS. 1 to 6 are denoted with the same reference

numerals.

In this microscope focusing apparatus, a plurality of screw holes 12e formed in the back surface of the focusing main body 10 are used to fix the main body to a support base 91 with bolts 92, and the microscope holder 21 is attached to the focusing movable portion 11 of the focusing main body 10.

A weight balance spring unit 30 comprises: a base 31 attached and fixed to the bottom surface of the focusing main body 10; a shaft 33 for guiding expansion and contraction of a compression coil spring 32; a cover 34 inserted along the shaft 33 so that the spring 32 is covered; and a movable frame 35 in which the spring 32 is inserted and which can vertically move with respect to the base 31 by the expansion and contraction of the spring. Moreover, the microscope holder 21 comprises a hole 21f into which the weight balance spring unit 30 is inserted, and a movable frame receiving portion 21g which is in contact with a tip end of the movable frame 35 to move together with the movable frame 35. The movable frame receiving portion 21g is screwed and fixed in a screw portion formed in an upper end of the hole 21f. A lower end surface of the movable frame receiving portion 21g forms an abutment portion 21h on which the movable frame 35 abuts by a balance force from the weight balance spring unit 30.

An outer diameter 35a of the movable frame 35 slidably engages with an inner diameter 34a of the cover 34. The movable frame 35 vertically moves along the inner diameter 34a of the cover 34 by the expansion and contraction of the spring 32 inserted in the movable frame 35.

Upward movement of the movable frame 35 is limited by a diaphragm 34b disposed on a tip end of the cover 34 and an end surface of the outer diameter 35a of the movable frame 35, and downward movement thereof is limited by a lower end surface of the movable frame 35 and a screw end surface of the shaft 33. Moreover, a movement amount of the movable frame 35 is allowed to meet a vertical movement amount of the microscope holder 21 attached to the focusing main body 10.

An air escape 35b is formed in the side surface of the movable frame 35 so that the movable frame 35 smoothly moves vertically.

FIG. 8 is an appearance view of the weight balance spring unit 30, and FIG. 9 is a diagram showing an attached state of the weight balance spring unit 30 in the bottom of the focusing main body 10.

As shown in FIGS. 7, 8, 9, the base 31 of the weight balance spring unit 30 comprises an attaching surface 31a for attaching the unit to the focusing main body 10, a hole 31b for fixing the bolt, and positioning portions 31c1, 31c2 for positioning the

unit. An attaching surface 12f, screw hole 12g, and positioning portions 12h1, 12h2 formed on the focusing main body 10 can be used to more easily attach/detach the unit by a plurality of bolts 36.

5           When the weight balance spring unit 30 is assembled between the microscope holder 21 and the focusing main body 10, an upward force acts on the microscope holder 21. As a result, the downward force applied to the focusing movable portion 11 (see FIG. 5) connected to the microscope holder 21 can be reduced, and weight balance can be kept.

10           Moreover, the weight balance spring unit 30 of FIG. 8 has two sliding movable frames 35, but one or three or more frames may be used in accordance with a required weight balance. Furthermore, when the movable frame receiving portion 21g and hole 21f are also disposed on the microscope holder 20 similarly as described above, the weight balance spring unit 30 can be assembled.

15           As described above, according to the microscope focusing apparatus of the second embodiment, the weight balance spring unit 30 can be attachably/detachably assembled with respect to the microscope holder 20 or 21 and the focusing main body 10. Therefore, it is possible to select the weight balance spring unit 30 having a different force amount in accordance with a load (weight of the microscope) applied to the

microscope holder 20 or 21 and attach the unit. The unit can be adjusted in an allowable load range of the focusing main body 10 which is defined by the focusing mechanism described in the first embodiment. Therefore, the microscope system can be inexpensively constructed without exclusively using the focusing main body 10 of the microscope focusing apparatus in accordance with the applied load unlike the conventional art.

FIG. 10 is a diagram showing the schematic configuration of the microscope focusing apparatus according to a third embodiment of the present invention. In FIG. 10, the same portions as those of FIGS. 1 to 9 are denoted with the same reference numerals.

The microscope focusing apparatus comprises: the microscope 1 shown in FIG. 1, and the like; and a focusing handle main body 100 and guide portion 200 (or 201) for vertically moving the microscope holder 20 (or 21) for supporting the microscope 1 and focusing on the sample 70. The focusing handle main body 100 and guide portion 200 (or 201) are integrally configured as described later, and therefore form the same configuration as the focusing main body 10. Additionally, the guide portions 200 and 201 have the same configuration except that the shape and size are different as described later.

The focusing handle main body 100 has a focusing

handle frame 120, a handle rotary shaft 14, and a  
focusing handle 16. The focusing handle frame 120 has  
an attaching surface 121 for attaching the guide  
portion 200 (or 201), positioning portions 122, 123  
5 having wall surfaces crossing at right angles to the  
attaching surface 121, and four counterbores 124.

FIG. 11 is a schematic sectional view showing a  
structure of the guide portion 200 (or 201) as viewed  
from above, and FIG. 12 is an appearance view of the  
10 guide portion 200 (or 201) as viewed from the back  
surface.

The guide portion 200 (or 201) has the focusing  
movable portion 11 for supporting the microscope holder  
20 (or 21) while vertically moving, and a guide frame  
15 210 for holding and guiding the focusing movable  
portion 11. Similarly, as the first embodiment, the  
front surface of the focusing movable portion 11 has  
the attaching surface 11a for attaching the microscope  
holder 20 (or 21), positioning portion 11c, and screw  
20 hole 11b. Moreover, a rack 230 and a stopper screw 231  
are attached to the back surface of the focusing  
movable portion. The rack 230 abuts on a groove 232  
formed in the focusing movable portion 11, and is  
positioned and fixed in the focusing movable portion 11  
25 via a screw 235.

On the other hand, stopper screws 231, 231 are  
screwed into the focusing movable portion 11 while

forming a vertical positional relation. Similarly as  
in the first embodiment, when the rotation of the  
pinion 14a of the focusing handle 16 is transmitted to  
the rack 230, the focusing movable portion 11 moves in  
the vertical direction. The stopper screws 231, 231  
cooperate with the focusing movable portion 11, and  
abut on upper or lower wall surfaces 211 or 212 of the  
guide frame 210 to limit a movement stroke of the  
focusing movable portion 11. The movement stroke of  
the guide frame 210 can be changed by changing  
positions of the stopper screws 231, 231 and a length  
of the rack 230. That is, the movement stroke of the  
guide frame 210 can easily be changed only by changing  
the guide portion 200 without changing the focusing  
handle main body 100.

The guide frame 210 has a guide main body frame  
213 and a single guide frame 214, and the guide groove  
12a for sliding the focusing movable portion 11 by the  
cylindrical roller 13 or balls is formed in both frames.  
Moreover, the single guide frame 214 is fixed to the  
guide main body frame 213 by a bolt 215, preload  
adjustment is performed, and the guide frame 210 is  
assembled.

An elongated groove 216 for securing movement of  
the rack 230 is disposed in the guide main body frame  
213, and the wall surfaces 211, 212 for limiting the  
movement stroke of the focusing movable portion 11 by

the stopper screws 213, 213 are formed on upper and lower end surfaces of the elongated groove 216.

Moreover, an attaching surface 219, three positioning pins 220, and a plurality of (eight) screw holes 221 are disposed on the back surface of the guide main body frame 213.

In FIG. 12, the wall surfaces 211, 212 for limiting the movement of the focusing movable portion 11 are shared with the elongated groove 216. However, another elongated groove may be formed separately from the elongated groove 16, and the wall surfaces 211, 212 may be formed in the elongated groove. In this case, the stopper screws 231, 231 vertically move in the another elongated groove, and are screwed into the focusing movable portion 11 to abut on the upper or lower wall surface 211 or 212 of the elongated groove. Moreover, when the another elongated groove is formed, one stopper screw 231 may be configured to abut on both the wall surfaces 211, 212.

A method of attaching the guide portion 200 (or 201) and focusing handle main body 100 will be described hereinafter. The attaching surface 219 on the back surface of the guide portion 200 (or 201) is abutted on the attaching surface 121 of the focusing handle main body 100, and is fixed via the counterbore 124 formed in the focusing handle frame 120 by the bolt 125. When a side portion of each positioning pin 220



of the guide portion 200 (or 201) is abutted on the wall surfaces of the positioning portions 122, 123 of the focusing handle frame 120, the guide portion and focusing handle main body can easily and securely be positioned.

Rigidity of the guide portion 200 (or 201) to be attached is changed in accordance with a thickness 222 of the guide groove 12a, shape and size 223 (thickness) of the guide frame 210, preload amount, guide system (roller, balls), material, and the like. Particularly, when the thickness 222 of the guide groove 12a, and the shape and size 223 (thickness) of the guide frame 210 are increased, the rigidity is effectively enhanced. Additionally, as shown in FIG. 10, the thickness 222 of the guide groove 12a, and the size 223 of the guide frame 210 are smaller in the guide portion 201 than in the guide portion 200.

Since the large guide portion 200 having a high rigidity, and the inexpensive and compact guide portion 201 having an insufficient rigidity can be selected and attached to the focusing handle main body 100, the microscope focusing apparatus can satisfy the demands of a broad range of usage.

As described above, according to the microscope focusing apparatus of the third embodiment, since the guide portion 200 or 201 is attachable/detachable with respect to the focusing handle main body 100, the guide

portion 200 or 201 having a different rigidity can be selected and attached to the focusing handle main body 100.

For the microscope holder 20 described in the first embodiment, the mounted microscope is lightweight, and the gravity position has a relatively short distance with respect to a movement axis 224 of the focusing movable portion 11. Since a moment generated in the microscope holder 20 is small, the guide portion does not require a high rigidity. On the other hand, for the microscope holder 21 described in the first embodiment, the mounted microscope is heavy, and the gravity position has a large distance with respect to the movement axis 224 of the focusing movable portion 11. A large moment is generated in the microscope holder 21, and therefore the guide portion requires a high rigidity to such an extent that the moment can be permitted.

The respective gravity positions of the microscope holders differ with the microscope focusing apparatus in this manner. To solve the problem, the weight balance spring unit 30 is prepared for the microscope holder, and is attached to and disposed in the gravity position so that the moment is prevented from being generated. However, this is difficult in the system.

Therefore, the guide portions 200, 201 are set to be attachable/detachable with respect to the focusing

handle main body 100, and the guide portions 200, 201  
different in rigidity from each other can be selected.  
Even when the weight and gravity position largely  
differ with the mounted microscope, the problem can be  
5 inexpensively solved without preparing the focusing  
main body 10 for exclusive use.

FIG. 13 is a diagram showing the schematic  
configuration of the microscope focusing apparatus  
according to a fourth embodiment of the present  
10 invention, and FIG. 14 is a schematic sectional view  
showing structures of the guide portion 200 (or 201)  
and a middle gear unit 300 as viewed from above. In  
FIGS. 13, 14, the same portions as those of FIGS. 1 to  
12 are denoted with the same reference numerals.  
15 Additionally, FIG. 13 is different from FIG. 10 in that  
the focusing handle main body 100 is viewed from a back  
surface side.

In this microscope focusing apparatus, the middle  
gear unit 300 is attached between the focusing handle  
20 main body 100 and the guide portion 200 (or 201) of the  
microscope focusing apparatus described in the third  
embodiment.

The middle gear unit 300 has a middle gear 310  
including a large gear 311 and a small gear 312, a gear  
25 shaft 313, and a bearing 317. One end of the gear  
shaft 313 is fixed to a holding frame 330 by a screw  
315, and the other end thereof is connected to the

bearing 317 via a screw 316. The middle gear 310 is held so as to be rotatable with respect to a shaft 318 of the gear shaft 313, and the position of the gear is limited left and right by end surfaces 319, 320.

5           The bearing 317 connected to the gear shaft 313 is fixed to the holding frame 330 by the screw 315. The gear shaft 313 is disposed in such a manner that the rotation of the pinion 14a of the focusing handle 16 is transmitted to the rack 230 of the guide portion 200  
10           (or 201) via the middle gear 310.

          Moreover, a distance 332 between an attaching surface 331 and a toothed portion of the pinion 14a is set to be equal to a distance 334 between an attaching surface 333 and the toothed portion of the rack 230 in  
15           order to transmit the rotation of the pinion 14a to the rack 230 even when the middle gear unit 300 is not inserted.

          A method of attaching the middle gear unit 300, focusing handle main body 100 and guide portion 200 (or  
20           201) will be described hereinafter with reference to FIG. 13. The holding frame 330 of the middle gear unit 300 has the attaching surfaces 331, 333, positioning portions 334, 335, three positioning pins 336, four screw holes 337, and four counterbores 338.

25           When the middle gear unit 300 is attached to the guide portion 200 (or 201), the respective positioning pins 220 of the guide portion 200 (or 201) are allowed

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to abut on the positioning portions 334, 334, 335 in order to position the guide portion. The attaching surface 333 is brought into contact with the attaching surface 219 of the guide portion 200 (or 201), and the middle gear unit is fixed by a bolt 339 via the counterbore 338.

On the other hand, when the middle gear unit 300 is attached to the focusing handle main body 100, similar to the method of attaching the guide portion 200 (or 201), the side portions of the respective positioning pins 336 of the middle gear unit 300 are allowed to abut on the wall surfaces of the positioning portions 122, 123 and are positioned. Moreover, the attaching surface 331 is brought into contact with the attaching surface 121 of the focusing handle main body 100, and the middle gear unit is fixed by a bolt 340 via the counterbore 124 formed in the focusing handle main body 100.

As described above, according to the microscope focusing apparatus of the fourth embodiment, the middle gear unit 300 is set to be attachable/detachable between the focusing handle main body 100 and the guide portion 200 (or 201). When the middle gear unit 300 is changed, the movement amount of the focusing movable portion 11 per one rotation of the focusing handle 16 can easily be changed. Moreover, the middle gear unit 300 includes the holding frame 330 and middle gear 310,

and is thus simply constituted. Therefore, the unit can be inexpensively manufactured.

FIG. 15A is a side view showing a configuration in which the microscope focusing apparatus according to the respective embodiments of the present invention is applied to various apparatuses, and FIG. 15B is a schematic plan sectional view. In FIGS. 15A, 15B, the same portions as those of FIG. 1 are denoted with the same reference numerals. A plurality of screw holes 12e are formed in a back surface 101 of the focusing main body 10, and a plurality of screw holes 401 are also formed in a support 400a of an apparatus 400. Moreover, in a stopper plate 500 for use in attaching the focusing main body 10 to the apparatus 400, a plurality of holes 501 and 502 are formed adapted to the screw holes 12e and 401.

When the focusing main body 10 is attached to the apparatus 400, first the stopper plate 500 is brought into contact with the back surface 101 of the focusing main body 10, and the respective screw holes 12e of the focusing main body 10 and the respective holes 501 of the stopper plate 500 are used to fix the stopper plate with respective bolts 503. Subsequently, the stopper plate 500 is brought into contact with the support 400a of the apparatus 400, and the respective screw holes 401 of the apparatus 400 and the respective holes 502 of the stopper plate 500 are used to fix the stopper

plate with respective bolts 504.

When the screw holes and bolts are used via the stopper plate 500 in this manner, the focusing main body 10 can be directly attached to an opposite component such as the apparatus and used. Additionally, examples of the apparatus to which the focusing main body 10 is attached include a test apparatus and an observation apparatus such as a wafer and a liquid crystal substrate.

According to the microscope focusing apparatus of the present invention, the following actions/effects are produced.

According to the present invention, in the microscope focusing apparatus including the focusing main body for supporting the microscope including the light illuminator, and vertically moving the microscope to focus on the sample, the holder for supporting the microscope is formed as the unit. Since the holder can easily be attached to/detached from the focusing main body, the microscope having a different attaching shape can be assembled without exclusively using the focusing main body or without increasing the cost. Moreover, when the size and length of the holder are changed, even with the microscope focusing apparatus fixed to the stand or the assembly apparatus, the position of the optical axis of the microscope can also be changed in accordance with any demand.

Furthermore, with the microscope supporting holder attachably/detachably attached to the focusing main body, even when the method of attaching the microscope differs, the holder having an attachable shape is selected, and the microscope can thus be attached to the focusing main body.

According to the microscope focusing apparatus of the present invention, during attaching of the holder to the focusing movable portion, the wall surfaces perpendicular to the respective attaching surfaces can be utilized to easily position the holder. Moreover, the holder can be inexpensively attached without requiring any conventional slide dovetail processed portion.

According to the microscope focusing apparatus of the present invention, the elastic member for keeping the weight balance is attached to the holder as an additional unit. Even when the weight of the microscope largely differs, the load applied in the focusing movement direction can be adjusted to be an optimum load for the ability of the elastic member.

According to the microscope focusing apparatus of the present invention, the guide portion is set to be attachable/detachable with respect to the focusing handle main body. Even when the weight and gravity position of the microscope largely differ, the guide portion having a different rigidity can be selected in



accordance with the magnitude of the moment applied to the guide portion. Moreover, since the guide portion is separate from the holder, the apparatus can be inexpensively manufactured.

5           According to the microscope focusing apparatus of the present invention, since the middle gear is attached as the additional unit between the guide portion and the focusing handle main body, the reduction ratio of the focusing handle can be selected.  
10       Since the guide portion and focusing handle main body are separate from and independent of each other, the middle gear can inexpensively be inserted with a simple structure.

15           According to the present invention, in the microscope focusing apparatus including the focusing main body for supporting the microscope including the light illuminator, and vertically moving the microscope to focus on the sample, the holder for supporting the microscope is formed as the unit. Since the holder can  
20       easily be attached to/detached from the focusing main body, the microscope having a different shape can be attached without exclusively using the focusing main body or without increasing the cost. Moreover, when the size and length of the holder are changed, even  
25       with the microscope focusing apparatus fixed to the stand or the assembly apparatus, the position of the optical axis of the microscope can also be changed in

accordance with any demand.

Moreover, according to the microscope focusing apparatus of the present invention, during attaching of the holder to the focusing movable portion, the wall surfaces perpendicular to the respective attaching surfaces are utilized to position the holder.

Therefore, the holder can be easily and securely attached to the portion inexpensively without requiring any complicated processing. Furthermore, for the holder, a round dovetail support shape which can support the microscope in a compact manner, and a wall surface support shape having general-purpose properties can be selected. Therefore, system properties are enhanced, and a broad range of user's requests can be satisfied.

Furthermore, according to the microscope focusing apparatus of the present invention, in order to keep the weight balance, the elastic member having a different force amount is selected, and attached as the additional unit to the holder and focusing main body. Therefore, the load applied to the focusing main body can be adjusted in an allowable range. Even when the mounted load changes because of the type of microscope or the attached unit, a suitable focusing main body does not have to be prepared, and the problem can be inexpensively solved.

Additionally, according to the microscope focusing

apparatus of the present invention, the focusing handle  
main body and guide portion are set to be  
attachable/detachable. Therefore, since the guide  
portion having a different rigidity can easily be  
5 selected, it is unnecessary to prepare the exclusive-  
use focusing main body for the change of the weight and  
gravity position of the microscope, and the apparatus  
can be inexpensively applied to a broad range of  
systems. Moreover, since the guide portion is single  
10 and independent, the movement stroke can be  
inexpensively and easily changed without changing the  
focusing handle main body. Furthermore, since the  
guide portion is attachable/detachable with respect to  
the microscope holder, only the guide portion can be  
15 changed without changing the microscope holder.  
Therefore, the guide portion can be inexpensively  
changed.

Moreover, according to the microscope focusing  
apparatus of the present invention, the middle gear  
20 unit is selected as the additional unit and attached  
between the focusing handle main body and the guide  
portion. Therefore, the movement amount of the  
focusing movable portion per one rotation of the  
focusing handle can be inexpensively changed without  
25 preparing the exclusive-use focusing main body.

As described above, according to the present  
invention, there can be provided the microscope

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5 focusing apparatus which can be broadly and  
inexpensively attached with respect to the attaching  
shape of the microscope including the light illuminator  
for lighting the sample. Moreover, according to the  
present invention, there can be provided the microscope  
focusing apparatus which can be broadly and  
inexpensively changed with respect to the weight and  
gravity position of the microscope including the light  
illuminator for lighting the sample. Furthermore,  
10 according to the present invention, there can be  
provided the microscope focusing apparatus in which the  
reduction ratio of the focusing handle of the  
microscope including the light illuminator for lighting  
the sample can be easily and inexpensively selected.  
15 That is, according to the present invention, there can  
be provided the microscope focusing apparatus to which  
the microscope can be broadly and inexpensively  
attached.

20 Additional advantages and modifications will  
readily occur to those skilled in the art. Therefore,  
the invention in its broader aspects is not limited to  
the specific details and representative embodiments  
shown and described herein. Accordingly, various  
modifications may be made without departing from the  
25 spirit or scope of the general invention concept as  
defined by the appended claims and their equivalents.